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1732

Attorney Docket No. 2000.16

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Runkle et al.

Group Art Unit: 1732

Serial No. 09/851,242

Examiner: Stefan Staicovici

Filed: May 26, 2004

For: METHOD FOR MAKING A HOLLOW FIBER MEMBRANE CONTACTOR

APPEAL: Reply to Examiner's Answer

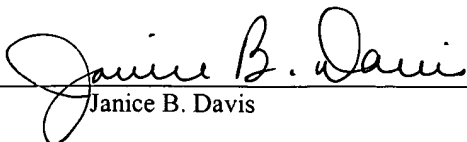
Mail Stop Appeal Brief-Patents
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This Reply Brief (in triplicate) is filed in response to the Examiner's Answer filed April 16, 2004, paper No. 20040413, which was a response to the appeal brief filed January 30, 2004, which responded to the Office Action mailed September 23, 2003 (Paper No. 19) and after the Notice of Appeal filed on December 23, 2003.

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, DC 20231, on May 26, 2004.


Janice B. Davis

1. REAL PARTY IN INTEREST

The real party in interest is Celgard Inc., the assignee of record in the instant application.

2. RELATED APPEALS AND INTERFERENCES

There are no related appeals or interferences.

3. STATUS OF THE CLAIMS

Claims 1-2, 4-5, 16-19, and 21-27 are the subject of this appeal. Claims 3, 20, and 28 are canceled. Claims 6-15 are withdrawn from consideration in view of a restriction requirement.

4. STATUS OF AMENDMENTS

Applicant has filed an Amendment After Final Rejection to cancel Claims 20 and 28.

5. SUMMARY OF THE INVENTION

The following is a concise explanation of the invention defined in the claims. The instant invention teaches a method for making a hollow fiber membrane contactor. Claim 1 recites the method of making hollow fiber membrane contactor as comprising the following steps: (1) winding a hollow fiber fabric 16 around a

center tube 12, Fig. 2; (2) potting 36 the fabric 16 and the tube 12 together, Fig. 2; (3) forming thereby a unitized structure; (4) placing the structure into a shell 20, Fig. 3; (5) second mold potting the structure and the shell 20 together by injecting a potting material into a space between the structure and the shell, Fig. 3; (6) and forming thereby a cartridge. In Claim 4, the method of making hollow fiber membrane contactor may, further, include the step of (7) heat-treating the cartridge.

6. ISSUES

First, whether Claims 1-2, 4-5, 19 are obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,186,832 ("Mancusi") in view of U.S. Patent No. 4,800,019 ("Bikson").

Second, whether Claims 16-18 are obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,186,832 ("Mancusi") in view of U.S. Patent No. 4,800,019 ("Bikson"), and in further view of U.S. Patent No. 4,961,760 ("Caskey").

Third, whether Claims 1-2, 4-5, 16, and 18-19 are obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,284,584 ("Huang") in view of U.S. Patent No. 5,186,832 ("Mancusi"), and in further view of U.S. Patent No. 4,800,019 ("Bikson").

Fourth, whether Claim 17 is obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,284,584 ("Huang") in view of U.S. Patent No. 5,186,832 ("Mancusi"), and in further view of U.S. Patent No. 4,800,019 ("Bikson") and U.S. Patent No. 4,961,760 ("Caskey").

Fifth, whether Claims 21-23, and 27 are obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,186,832 ("Mancusi") in view of U.S. Patent No. 4,800,019 ("Bikson"), and in further view of Applicants' admitted prior art.

Sixth, whether Claims 24-26 are obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,186,832 ("Mancusi") in view of U.S. Patent No. 4,800,019 ("Bikson"), and in further view of Applicants' admitted prior art and U.S. Patent No. 4,961,760 ("Caskey").

Seventh, whether Claims 21-24 and 26-27 are obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,284,584 ("Huang") in view of U.S. Patent No. 5,186,832 ("Mancusi"), and in further view of U.S. Patent No. 4,800,019 ("Bikson") and Applicants' admitted prior art.

Eighth, whether Claim 25 is obvious under 35 U.S.C. 103(a) over U.S. Patent No. 5,284,584 ("Huang") in view of U.S. Patent No. 5,186,832 ("Mancusi"), and in further view of U.S. Patent No. 4,800,019 ("Bikson") and Applicants' admitted prior art.

7. GROUPING OF THE CLAIMS

Claims 1-2, and 16-19 stand together as a group. Claims 4-5 stand together as a group. Claims 21-27 stand together as a group.

8. ARGUMENT

Claims 1-2, 4-5, 16-19, and 21-27, for the reasons explained hereinafter, are not obvious under 35 U.S.C. 103(a). Thus, the above-mentioned 103 rejections are improper, and they must be removed. The errors made by the Examiner are discussed after a discussion of the invention and the cited references.

a. THE INVENTION

The instant invention is directed to a method of making a hollow fiber membrane contactor, which comprises two potting steps: a first potting step, and a second potting step, described hereinbelow in detail. These two potting steps are quintessential in formation of a seal, which is capable of overcoming the problems arising from potting shrinkage, specifically, in contactors with a diameter greater than 10 inches. Referring to instant specification and figures 2-4, the manufacture of the hollow fiber membrane contactor is illustrated below.

In figure 2, shown below, "center tube 12 is used as a mandrel. Hollow fiber fabric 16 is wound around tube 12. Simultaneously with winding, potting resin beads 36 are laid at the lateral edges of fabric 16 and form tube sheets 18, i.e., the first or bead-potting step. Optionally, a bead 38 may also be laid between beads 36, thereby forming spacer 34. At the conclusion of this step, the potting is, preferably, a gelatinous solid 37 and the unitized structure is formed.

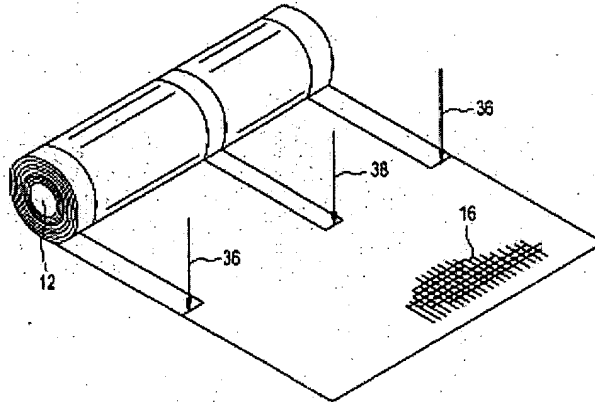


Fig.2

After the first potting step, the unitized structure is inserted into the shell 20. Shell 20 and the structure are inserted into a mold 42." (Specification, Page 7, Line 20 - Page 8 Line 6).

Referring to figure 3, "mold 42, preferably, consists of a part that engages shell 20, a center mold piece 44 that engages

tube 12, and potting injection ports 46. The mold thereby centers the unit within the shell." (Specification, Page 8, Lines 8-11).

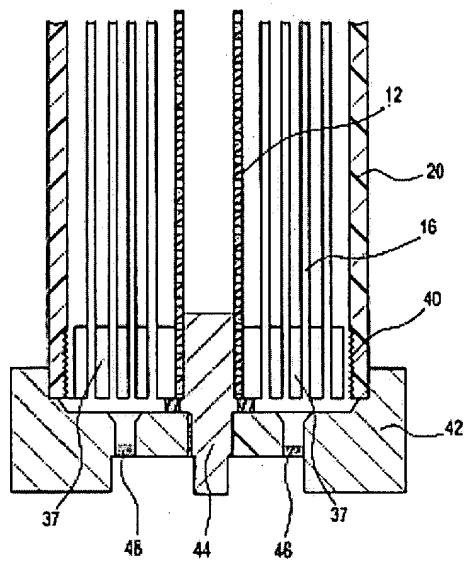


Fig. 3

Referring to figure 4, "a second potting material 48 is injected through the mold, into the space between shell 20 and solid 37, and thereby joins the shell to the unitized structure, i.e., the second or mold-potting step." (Specification, Page 8, Lines 13-18).

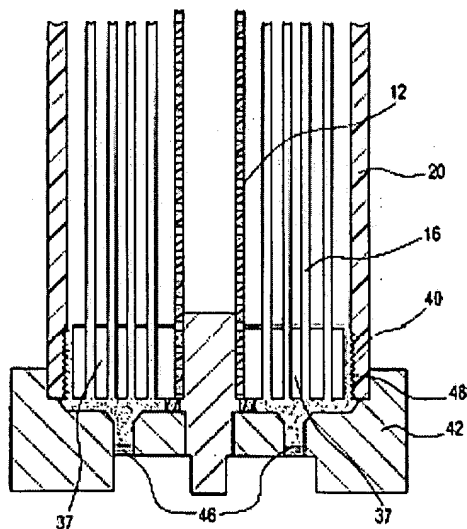


Fig. 4

"The potting resins are allowed to solidify. The cartridge is removed from the mold. The ends are, preferably, subjected to a rotary cut to open the end of the hollow fibers and to generate a planar cut surface that is perpendicular to the centerline of the cartridge." (Specification, Page 8, Lines 20-24).

"After the two potting steps described above, the cartridge is, preferably, heat-treated. Heat-treatment increases the thermal/mechanical integrity of the cartridge by reducing residual stress. Additionally, when an epoxy potting is used, this heat-treatment further cross-links and hardens the potting. Reduced stress lessens the occurrence of cracking at interfaces and joints." (Specification, Page 9, Lines 2-7).

According to the instant application, "although contactors with ten (10) inch diameter are commercially available, these contactors are difficult to seal because of potting shrinkage." (Specification, Page 2, Lines 10-13). The instant invention resolves the difficulties associated with formation of a seal between the tube sheets and the shell due to the potting shrinkage. Furthermore, as shown in Claim 21, the instant invention provides a hollow fiber membrane contactor with a diameter greater than six

inches while maintaining the integrity of the seal between the tube sheets and the shell.

b. CITED REFERENCES

U.S. Patent No. 5,186,832 ("*Mancusi*"), assigned to the real party in interest of the instant appeal, is directed to a spiral-type hollow fiber membrane fabric-containing cartridges and modules for separation and other phase contact applications. (Column 1, lines 13). According to *Mancusi*, (1) the hollow membrane fabric and integrally-bonded turbulence-promoting web is wound onto the surface of the hollow core mandrel to form a spirally-wound membrane bundle (Column 8, lines 44-47); (2) the two ends of the bundle are potted in resinous potting material serving to seal each of the bundle ends into a monolithic tube sheet and complete the cartridge (Column 9, lines 1-8); (3) one or both of the potted ends of the bundle are then trimmed so that the lumen ends of each hollow fiber at the trimmed end(s) will be exposed (Column 9, lines 14-17); (4) the potted bundle is fitted into a suitable housing to yield a module and facilitate operation (Column 9, lines 18-19); (5) the tube sheet(s) adjacent to the bundle end(s) with exposed lumens is(are) **sealed** to the interior of the housing, to positively prevent fluid flow between the shell side and the lumen side without passage through the membrane (Column 9, lines 23-27); and

(6) end cap means suitably shaped to seal each of the two open housing ends are provided (Column 9, lines 33-34).

Furthermore, according to *Mancusi*, cast-in-place modules can be made by the steps of: (1) starting with (a) a bundle prepared as discussed above, and (b) a conventional cast-in-place housing, which is generally made of plastic; (2) inserting the bundle into the housing; (3) potting both of the bundle ends after sealing the bundle ends with a potting cup clamped over each end of the housing; and (4) providing suitable end caps and ports. (Column 9, line 63 - Column 10, line 3).

However, *Mancusi* does not teach or suggest anything about employing a two potting steps method, as required by the instant invention to form a seal between the tube sheets and the shell. Furthermore, *Mancusi* does not teach or suggest anything about heat-treatment of the cartridge to cure the potting between the tube sheets and the shell in order to resolve the problems associated with the seal between the tube sheets and the shell, which is due to the shrinkage of the potting materials. Furthermore, the creation of seal between the tube sheets to the interior of the housing in *Mancusi* is, in fact, facilitated via the use of O-rings as shown in the Declaration submitted by Charles J. Runkle (attached hereto as "Exhibit A").

U.S. Patent No. 4,800,019 ("*Bikson*") is directed to a method of producing a porous hollow semipermeable membrane device. (Column 3, lines 18-20). According to *Bikson*, one or both ends of a plurality or a bundle of porous hollow fibers is embedded or potted in a tube sheet. (Column 4, lines 48-51). According to *Bikson*, the end of the hollow fiber bundle is placed in a mold, and the mold is filled with the potting resin composition to form the tube sheets. (Column 4, lines 53-55). The tube sheet or potted portion of the module is subsequently heat treated by the process according to *Bikson*. (Column 4, lines 60-68). Heating is continued for a period of time sufficient to essentially densify the porous walls of the hollow fibers in the potted portion of the tube sheet. (Column 3, lines 28-30). As a consequence of this heat treatment, the hollow fiber in the tube sheet densifies and the bores of the portion of the hollow fibers embedded in the tube sheet now have a larger inside bore diameter than the inside bore diameter of the portion of the porous hollow fiber not embedded in the tube sheet. (Column 8, lines 27-33). In addition, the walls of the hollow fibers, embedded in the tube sheet, are now essentially fully dense and non-compressible. (Column 8, lines 33-36). The fibers will not shrink from the potting-fiber interface at operating pressures during fluid separation processes and there is essentially no leakage at the interface between the outside

surface wall of the hollow fibers and the tube sheet. (Column 8, lines 36-40). Also, because the inside diameter of the fiber bore openings has increased due to the hollow fiber wall densification, pressure drop through the bores in the tube sheet during fluid separation operation is lower. (Column 8, lines 40-44). Another advantage is that the opening of the fiber bore ends in the tube sheet is facilitated due to the larger bore openings present. (Column 8, lines 44-46).

However, *Bikson* does not teach or suggest anything about employing a two potting steps method, as required by the instant invention to form a seal between the tube sheets and the shell. Furthermore, *Bikson* does not teach or suggest anything about heat-treatment of the cartridge to cure the potting between the tube sheets and the shell in order to resolve the problems associated with the seal between the tube sheets and the shell, which is due to the shrinkage of the potting materials.

U.S. Patent No. 4,961,760 ("*Caskey*") is directed to hollow fiber membrane fluid separation device specially adapted for boreside feed. *Caskey* discloses that tube sheets may be made from a variety materials, i.e. epoxy, polyurethane, and acrylic resins. (Column 7, lines 40-43).

However, *Caskey* does not teach or suggest anything about employing a two potting steps method, as required by the instant invention to form a seal between the tube sheets and the shell. Furthermore, *Caskey* does not teach or suggest anything about heat-treatment of the cartridge to cure the potting between the tube sheets and the shell in order to resolve the problems associated with the seal between the tube sheets and the shell, which is due to the shrinkage of the potting materials.

U.S. Patent No. 5,284,584 ("*Huang*"), assigned to the real party in interest of the instant appeal, is directed to a method of fabricating a spiral-type hollow fiber membrane fabric-containing cartridge. (Column 4, lines 12-14). According to *Huang*, "(1) hollow fibers are fabricated into a fabric-like array; (2) the fabric-like array is wound onto the mandrel surface to form a spirally wound, cylindrical shape membrane bundle; (3) the ends of the membrane bundle is potted in resinous potting material serving to seal each of the bundle ends into a monolithic tube sheet; (4) the potted ends of the bundle is trimmed so that the lumen ends of each hollow fiber at the trim end is exposed; (5) potted bundle is fitted into a housing; and (6) the tube sheet(s) adjacent to the bundle end(s) with exposed lumens is(are) sealed to the cylindrical interior of the housing, to positively prevent fluid flow between

the shell side and the lumen side without passage through the membrane." (Column 7, line 6 - Column 9, line 16).

However, *Huang* does not teach or suggest anything about employing a two potting steps method, as required by the instant invention to form a seal between the tube sheets and the shell. Furthermore, *Huang* does not teach or suggest anything about heat-treatment of the cartridge to cure the potting between the tube sheets and the shell in order to resolve the problems associated with the seal between the tube sheets and the shell, which is due to the shrinkage of the potting materials. Furthermore, the creation of seal between the tube sheets to the interior of the housing in *Huang* is, in fact, facilitated via the use of O-rings as shown in the Declaration submitted by Charles J. Runkle (attached hereto as "Exhibit A").

c. DISCUSSION OF THE EXAMINER'S ERROR

The central issue to this Appeal is whether U.S. Patent No. 5,186,832 ("*Mancusi*"), as the Examiner argues, teaches two potting steps or whether this reference, as the Applicants have continuously stated, only teach a single potting step.

The Examiner states that that *Mancusi* teaches the basic claimed process of making a hollow fiber membrane separation device (contactor) including, providing a core, wrapping a hollow fiber fabric onto said core (winding), **potting the fabric and core together to form a an assembly (first potting)**, placing the assembly in a housing (shell) and **potting the assembly and the housing interior to form a cartridge (second potting)**. (See Col. 8, Lines 44-48, Col. 9, Lines 1-7, and 60-68 and Col. 10 (It is believed to be erroneously designated as Column 9 in Examiner's Answer), Lines 41-60) (See Examiner's answer page 3 last paragraph). The Examiner further states that it should be noted that *Mancusi* specifically teaches **potting of the tube-sheets to the interior of the housing**. (See Col. 9, Lines 22-27) (See Examiner's answer page 3 last paragraph).

The relevant portions of *Mancusi* cited by the Examiner as discussed hereinbelow include the following:

First, the Examiner is correct in characterizing the following portion of *Mancusi* as the "winding" step:

"The fabric-like array and integrally-bonded turbulence-promoting web is then wound onto the core surface (or itself, if no core is used) to form a spirally-wound membrane bundle having two **bundle ends** communicating with the mandrel bore." (Column 8, Lines 44-48).

Second, the Examiner is correct in characterizing the following portion of *Mancusi* as the "first potting" step:

"Next, the **two ends of the bundle** are potted in resinous potting material serving to **seal each of the bundle ends into a monolithic tube sheet and complete the cartridge (only potting step)**. Both the materials and the basic methodology for carrying out potting to form tube sheets are well known in the art, as shown, for example, in the Caskey U.S. Pat. No. 4,961,760 which is hereby incorporated herein by reference." (Column 9, Lines 1-7).

Third, the Examiner, however, is in error to characterize the following sections as the second potting step.

A. "Cast-in-place modules according to the invention can be made by the steps of: (1) starting with (a) a bundle prepared as discussed above, and (b) a conventional cast-in-place housing, which is generally made of plastic; (2) inserting the bundle into the housing; (3) potting both of the **bundle ends** after sealing the bundle ends with a potting cup clamped over each end of the housing (**only potting step**); and (4) providing suitable end caps and ports." (Column 8, Line 60 to Column 9, Line 3).

B. "In such cases, according to preferred embodiments of the invention, **potting is accomplished by forming the end seals for the bundle ends simultaneously with the winding of the array and web into a bundle, instead of employing a subsequent potting step**. This potting operation is accomplished by putting down continuous resinous potting material lines at both bundle ends beginning at the unwound edge of the fabric facing and adjacent the nip with the axis, and proceeding along the fabric edge, **forming continuous end seals at both bundle ends extending to the perimeter of the bundle**. The width of the end seals generally should be great enough to withstand the full operating pressure of the cartridge. The bundle ends can be sealed to the housing interior as needed, by simply applying an appropriate amount of resinous potting material to the edge adjacent the bundle ends. Alternatively, a ring-shaped fitting designed to tightly rest against the end of the housing interior can be fabricated (e.g., injection

molded), and adhesively attached to the edge adjacent the bundle end." (Column 10, Lines 41-60).

C. "After the bundle is installed in the housing, the tube sheet(s) adjacent to **the bundle end(s)** with exposed lumens is(are) **sealed to the interior of the housing**, to positively prevent fluid flow between the shell side and the lumen side without passage through the membrane." (Column 9, Lines 22-27).

Examiner has failed to show the second potting step because the Examiner has misconstrued the abovementioned three portions of *Mancusi*.

With regard to preceding portion of *Mancusi* designated above as section "A," this section discloses the method of forming the tube sheets, and there is only one potting step.

With regard to preceding portion of *Mancusi* designated above as section "B," this section teaches the formation of tube sheets simultaneously with the winding step. Furthermore, *Mancusi* discloses that bundle ends can be sealed to the housing interior by simply applying an appropriate amount of potting material. However, *Mancusi* employs the term **bundle ends** to refer to end point of the bundle of fibers prior to formation of the tube sheets, i.e. end seals. Therefore, sealing bundle ends to the housing interior by simply applying an appropriate amount of potting material does not refer to a second potting step because no precedent potting step has occurred yet, i.e. no tube sheets has been formed; thus,

there is only one potting step. In addition, *Mancusi* utilizes the term **end seals** to show that formation of tube sheets has occurred, as used in section "B." Therefore, *Mancusi* discloses a one-step potting in section "B."

With regard to preceding portion of *Mancusi* designated above as section "C," this section discloses that **bundle ends** are sealed to the interior of the housing. However, *Mancusi* employs the term **bundle ends** to refer to end point of the bundle of fibers prior to formation of the tube sheets, i.e. end seals. Therefore, sealing bundle ends to the housing interior does not refer to a second potting step because no precedent potting step has occurred yet, i.e. no tube sheets has been formed; thus, there is only one potting step. In addition, *Mancusi* utilizes the term **end seals** to show that formation of tube sheets has occurred, as shown in the bolded portion of section "B." Therefore, *Mancusi* discloses a one-step potting in section "C."

Furthermore, Charles Runkle, the instant inventor, who is also one of the inventors of *Mancusi*, has submitted a Declaration under Rule 132, which affirmatively states that the above-mentioned section "C" does not refer to a second potting step; in fact, it affirmatively states that the above-mentioned section "C" refers to the use of O-rings to form a seal. Attached hereto is a copy of

the Declaration provided by Charles Runkle. However, the Examiner has failed to properly consider the Runkle's Declaration. Applicants point out that nowhere in the Examiner's answer is any mention made to the Runkle Declaration. In the usual ex parte proceeding, the PTO establishes a *prima facie* case of obviousness; the burden of proof then shifts to the applicant; if possible, the applicant then introduces by affidavit factual evidence of non-obviousness to try to rebut the *prima facie* case. *In re Palmer*, 59 CCPA 733, 451 F.2d 1100, 172 USPQ 126 (1971); *In re Antle*, 58 CCPA 1382, 444 F.2d 1168, 170 USPQ 285 (1971). The PTO is required to reconsider its *prima facie* case in light of the applicant's rebuttal evidence and must make a decision based upon the record as a whole. *In e Carleton*, 599 F.2d 1021, 202 USPQ 165 (CCPA 1979); *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976). Therefore, the instant invention must be considered in light of Runkle's Declaration.

In addition, it is also noted that in Column 10, lines 42-45 *Mancusi* states "... potting is accomplished by forming the end seals for the bundle ends simultaneously with the winding of the array and web into a bundle, instead of employing a subsequent potting step." This is a clear teaching away from the use of two potting steps. Teaching away from the art is per se demonstration

of a **lack** of *prima facie* obviousness. In re Dow Chemical Company
837 F. 2d 469, 5 USPQ2d 1529 (Fed. Cir. 1988).

Throughout the rejections of claims under 35 USC § 103 *Mancusi* is included in each and everyone of these rejection to provide the basis for Examiner's argument, i.e. teaching of two potting steps. Since *Mancusi* only teaches a single potting step, then, there is no teaching of two potting steps. Therefore, since the basis for Examiner's argument does not stand, then, it follows that the Examiner's argument shall not stand either. Therefore, the instant application must be unobvious from the prior art.

CONCLUSION

In view of the forgoing comments, Claims 1-2, 4-5, 16-19, and 21-27 are not obvious under 35 U.S.C. 103(a); therefore, the Applicant respectfully requests an early Notice of Allowance in the instant application.

Respectfully submitted,



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EXHIBIT A

Attorney Docket No. 2000.16

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Runkle, et al

Art Unit: 1732

Serial No. 09/851,242

Examiner: S. Staicovici

Filed: May 8, 2001

For: HOLLOW FIBER MEMBRANE CONTACTOR
AND METHOD FOR MAKING SAME

DECLARATION UNDER RULE 132

I, Charles J. Runkle, declare:

1. I am a named inventor in the above captioned application.
2. I am also a named inventor in U.S. Patent Numbers 5,186,832 (Mancusi et al) and 5,284,584 (Huang et al) cited against the above captioned application.
3. In the instant application, Paper No. 6, page 4, paragraph 9, and page 6, paragraph 12, the Examiner states:
"..., it should be noted that Mancusi et al ('832) specifically teach potting of the tube-sheets to the interior of the housing (see col. 9, lines 22-27)."
4. The Examiner's interpretation of that portion of Mancusi et al is incorrect.

5. The portion of Mancusi et al cited by the Examiner states:

"After the bundle is installed in the housing, the tube sheet(s) is (are) sealed to the interior of the housing, to positively prevent fluid flow between the shell side and the lumen side without passage through the membrane."

6. That portion does not refer to "potting the structure and the shell together."

7. That portion refers to the use of o-rings to form a seal.

8. The portion of Mancusi et al cited by the Examiner and set out in Paragraph 5 above appears in Huang et al at column 9, lines 11-16.

9. Therein, it is stated that the "bundle" is "sealed" to the "housing."

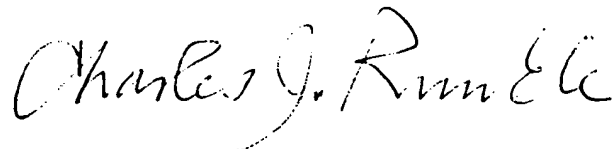
10. In that passage, "sealed" refers to the use of o-rings.

11. At Huang et al, column 21, lines 58-61 and Figure 6, it is shown that "sealing" refers to o-rings.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that these statements were made

with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

A handwritten signature in cursive script, reading "Charles J. Runkle". The signature is written in dark ink and is positioned above the printed name.

Charles J. Runkle

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Docket No. 2000.16
SERIAL NO. 09/851,242
ART UNIT 1732

APPENDIX

1. A method of making a hollow fiber membrane contactor comprising the steps of:

winding a hollow fiber fabric around a center tube,

first potting the fabric and the tube together,

forming thereby a unitized structure,

placing the structure into a shell,

second mold potting the structure and the shell together by injecting a potting material into a space between the structure and the shell, and

forming thereby a cartridge.
2. The method of claim 1 wherein the first-mentioned potting being bead potting.
4. The method of claim 1 further comprising the step of heat-treating the cartridge.

5. The method of claim 4 wherein the heat-treating further comprises a first heat-treating and a second heat-treating.

16. The method of claim 1 wherein potting further comprises the first or the second potting with a material selected from the group consisting of thermosetting materials and thermoplastic materials.

17. The method of claim 16 wherein the thermosetting material being selected from the group consisting of epoxy and polyurethane.

18. The method of claim 16 wherein the thermoplastic material being selected from the group consisting of polyolefins and polyurethanes.

19. The method of claim 1 wherein placing the structure into a shell further comprises centering the structure in the shell.

21. A method of making a hollow fiber membrane contactor comprising the steps of:

winding a hollow fiber fabric around a center tube to a diameter of at least six inches,
bead potting the fabric and the tube together,
forming thereby a unitized structure,
placing the structure into a shell,
mold potting the structure and the shell together by injecting a potting material into a space between the structure and the shell, and
forming thereby a cartridge.

22. The method of claim 21 further comprising the step of heat-treating the cartridge.

23. The method of claim 22 wherein the heat-treating further comprises a first heat-treating and a second heat-treating.

24. The method of claim 21 wherein bead or mold potting further comprises using a material selected from the group consisting of thermosetting materials and thermoplastic materials.

25. The method of claim 24 wherein the thermosetting material being selected from the group consisting of epoxy and polyurethane.

26. The method of claim 24 wherein the thermoplastic material being selected from the group consisting of polyolefins and polyurethanes.

27. The method of claim 21 wherein placing the structure into a shell further comprises centering the structure in the shell.

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